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REGISTRATION OF LOW-ENERGY PROTONS ABOARD AES OF THE SERIES "ELEKTRON"

by

E. N. Sosnovets

(USSR)

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by E. N. Sosnovets

SUMMARY

The general pattern of trapped protons' distribution around the Earth is constructed on the basis of measurements carried out on 4 AES of the series Elektron. The results so obtained could be compared because the type of the sensors installed on all of them was identical. The characteristic singularities of the distribution of protons of various energies are defined.

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The launching of satellites of the series "Elektron" (on 30 January and 11 July 1964) allowed us to investigate low energy protons (E_p = 1.0 ÷ 30 Mev) in a broad region of space during a period close to solar activity minimum. The characteristics of satellite orbits and of the instrumentation are given in ref.[1]. An identical complex of sensors was installed on each of the four satellites, which provided the possibility of comparing the results obtained in various portions of space at different times.

PROTON DETECTORS.

Only part of the results related to protons with $1 < E_p < 9$ Mev is given in this paper. Scintillation and semiconductor counters were used for detectors and installed outside the satellite's casing. The crystals used in the scintillation counters were made of GJ(Tl) with thickness of ∿ 0.15 and ∿ 3 mm. The counter with the thin crystal served for measuring protons in the energy range $(1.5 \pm 0.2) < E_p < (10 \pm 2)$ Mev, while that with the thick crystal measured protons in the $(5 \pm 0.5) < E_p < (80 \pm 20)$ Mev and $(9 \pm 1) < E_p < (30 \pm 5)$ Mev energy intervals. The crystals were covered by foil ∿ 2 mg cm^{-2} Al within the limits of a ∿ 40° angle in both counters. In all other directions the crystals were shielded by ∿ 1.5 – 2 cm Pb. The circuits of the scintillation counters are described in [2, 3].

(*) REGISTRATSIYA PROTONOV MALYKH ENERGIY NA SPUTNIKAKH SERII "ELEKTRON"

AES = artificial Earth Satellite

Protons in the $(1.0 \pm 0.2) < E_p < (5 \pm 1)$ Mev energy range were registered with the aid of semiconductor counters. In order to shield the counters from solar light they were closed by foil of $\sim$ 2mg cm^{-2} Al.

After threshold calibration on an accelerator, the value of the threshold was controlled in the course of pre-flight tests with the aid of α-sources.

R E S U L T S .

From detectors the information was fed to a memory device. The latter could operate in three temporal regimes, at which the accumulation time of information between memory cycles constituted 15, 105 and 465 sec. These times were found to be commensurate with the rotation period of the satellites which constituted respectively $\sim$ 40 and $\sim$ 120 sec for low and high satellites. In the second and third regimes practically no intensity modulation of any sort was noticeable, and in the first regime the modulation factor of proton channels did not exceed the factor of two. Thus, the results obtained provide the magnitude of the mean directed intensity of protons with a precision to a factor of $\sim$ 2.

The distribution of protons may be plotted in geomagnetic coordinates on the basis of primary data.Parameter L and the intensity of the magnetic field B were chosen for such coordinates. Plotted in Fig.1 are the altitude courses that is, the dependence of intensity on latitude for certain fixed L; represented also in this figure are the experimental points related to the detectors of protons installed on various satellites. Points on L = 1.3, 1.6 and 2 were obtained on Elektron-3 in July 1964; the points on L = 3 were obtained on AES Elektron-1 and -2 in February 1964. The points lying on L = 3 near the equator are related to Elektron-2. The readings of all the devices were normalized to the geometrical factor of the detector of Elektron-1, which constituted about $1.1 \cdot 10^{-1}$ cm^2 sterad.

It may be seen from Fig.1 that as L increases, the altitude dependence becomes weaker, i. e., the angular distribution of protons relative to the line of force of the magnetic field becomes more isotropic. There is also a tendency to point scattering with the increase of B and L. The latitude dependence of point scattering may be partially explained by detector rotation effect, for as the latitude increases, the angular distribution becomes narrower. However, the increase of point scattering with the rise of L can not be explained by an analogous effect, inasmuch as then the angular distribution becomes wider. An analogous dependence of point scattering was observed in the works [4, 5]. This scattering of points may be explained by temporary variations of protons. This effect of temporal variations was particularly clearly observed in [5], where the inaccuracy in the distribution of coordinates was hardly manifest.

On the basis of the graphs similar to those represented in Fig.1 it is possible to construct the total pattern of distribution of trapped protons around the Earth (refer to Figs. 2 and 3 in the following).

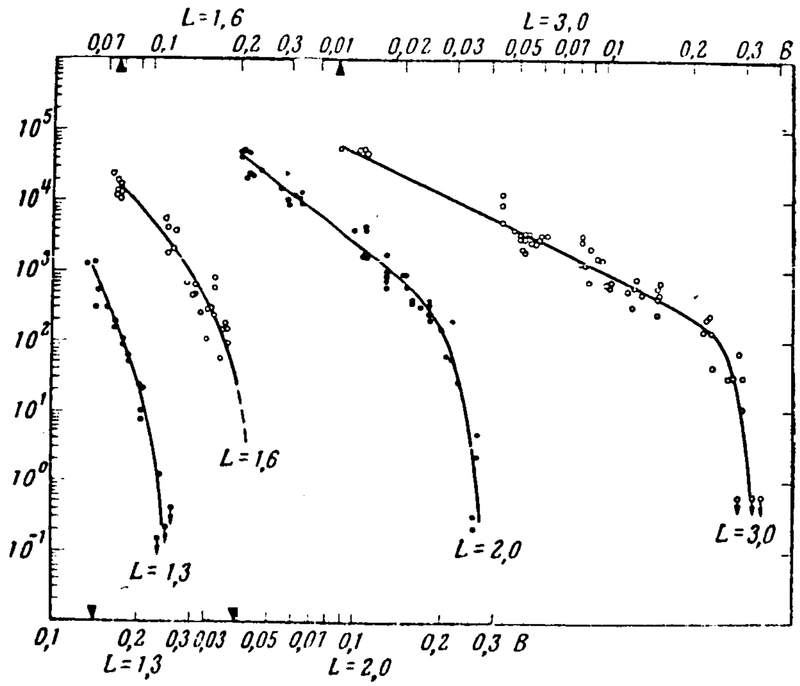

Fig.1. Altitude course of protons with energy 1.5 < E_p < 15 Mev on L = 3; 1.6; 2.0 and 3.0. There is given for L its own scale of B. The black triangles denote the position of the geomagnetic equator for every L

South

North

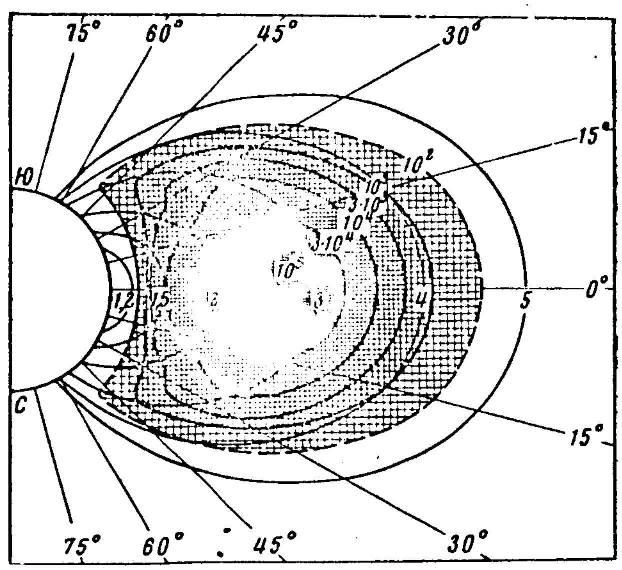

Fig.2. Distribution of protons with energy 1.5 < E_p < 15 Mev in the magnetic meridian plane. Solid lines represent the lines of equal intensity in pulse sec^{-1}

The distribution of protons with $E_p > 1.5$ Mev in the magnetic meridian plane is plotted in Fig.2. Fig.3 gives the distribution pattern of protons with various energies in the plane of the magnetic meridian as a function of L.

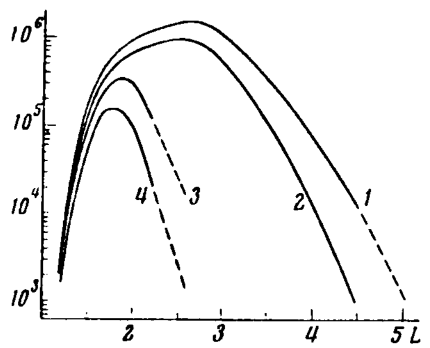

Fig.3. Distribution of protons of various energies in the plane of the magnetic equator.

1) $E_p > 1$; 2) $E_p > 1.5$;
3) $E_p > 5$; 4) $E_p > 9$ Mev.

It may be seen from Fig.3 that the characteristic singularities in the distribution of protons are as follows:

1) the position of the maximum depends on the energy of protons and shifts towards greater L as the energy decreases;

2) the value of intensity increases with the decrease of energy;

3) the dependence of intensity on L becomes feebler beyond the maximum as the energy decreases;

4) The integral energy spectrum of protons becomes softer with increase of L;

5) there are practically no protons in the energy range $1 < E_p < 5$ Mev on $L < 1.5$.

Therefore, the results obtained are not in contradiction with the experimental data of preceding investigations [4, 6] and they agree well with theory [7, 8]. So far it is not clear whether or not systematic variations take place in the geometrical distribution, intensity and spectrum of protons, linked with phase variation of the cycle of solar activity, inasmuch as the investigations of protons of this energy region have begun after the activity maximum.

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***** THE END *****

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VOLT TECHNICAL CORPORATION
1145 - 19th St. NW
WASHINGTON D.C. 20036.
Telephone: 223-6700 (Ext. 36 & 37).

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